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Project Summary

Method Validation and Application for Semivolatile Organic Compounds in Dust and Soil: Pesticides and PCBs

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Recent studies in residential exposure have given new understanding to the ways in which humans are exposed to persistent pollutants. The use (inadvertent or by choice) of products around the home which contain persistent pollutants, such as lawn herbicides and indoor insecticides, results in persistent residues inside the home. Indirect contamination may also occur from regional dispersion of these pollutants.

Once pollutants enter the home, carpets, house dust, and home furnishings become long-term reservoirs. Residues on floors and surfaces can become a source of chronic exposure for young children through the hand-to-mouth route of ingestion.

This work was designed to evaluate the extent to which persistent organic pollutants from diverse chemical classes are present in the outdoor soil, entry-way soil, and house dust of representative lower socioeconomic homes. Those pollutants evaluated included organophosphate insecticides (OP), a cyanoaromatic fungicide (CN), organochlorine insecticides (OC), an acidic lawn herbicide (HA), a chlorinated phenol (multipurpose insecticide, fungicide, and herbicide; HA) and polychlorinated biphenyls (PCB). Analyses were conducted using several different analytical approaches. The methods were applied to evaluate the precision and accuracy, and the trade-offs in these modes of analysis that are made with different extraction, cleanup, and detection methods.

The results of this study indicate that all persistent organic pollutants evaluated are present to some extent in the lower socioeconomic homes that were studied. The pollutants are primarily present in the house dust, rather than outdoor soils, and when present in both matrices are present at higher levels (weight basis in the media, g/g) in the house dust. Even those chemicals such as the lawn herbicide 2,4-D, that would not have been used in the home or near a foundation, were detected consistently in the house dust of all homes.

The levels of the persistent pollutants in these house dust samples are similar to the average levels that have been reported in other studies. Levels in dust ranged from low (0.02 g/g) to moderate (0.5 g/g); in a few cases, for the insecticides diazinon and chlorpyrifos, levels above 1 g/g, up to 25 g/g, were found. The fungicide chlorothalonil was detected at the lowest levels and least frequency. The insecticides diazinon and chlorpyrifos, lawn herbicide 2,4-D, and pentachlorophenol (PCP) were the analytes detected most frequently.

The comparison of analytical methods in this study indicated that sonication extraction with a simple solid phase extraction (SPE) cleanup step may provide more reliable data than that which can be achieved with Soxhlet extraction and no cleanup. An additional benefit to this approach is the possibility of conducting analyses with lower cost GC/ECD analyses, rather than with higher cost GC/MS analyses.

This Project Summary was developed by EPA's National Exposure Research

Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Persistent pollutants, including metals, pesticides, and PCBs, have been studied extensively over the last 25 years because of their adverse effects on ecosystems, wildlife, water quality and air quality. Analyses for these persistent pollutants have focused on media such as water, soil, sediment, and wildlife tissue. These media are reservoirs in the environment that can indicate the extent to which persistent pollutants have migrated from source, production, application, or disposal area. The Clean Water Act and the Clean Air Act have led to control of sources and with that, reduction in gross pollution of air and water. However, the environment retains many persistent pollutants in media reservoirs for years after production and use have ceased.

Recent studies in residential exposure have given new understanding to the ways in which humans are exposed to these persistent pollutants. The use (inadvertent or by choice) of products around the home that contain persistent pollutants, such as lawn herbicides and fungicides, indoor and home foundation insecticides, pentachlorophenol (PCP) treated wood, or chromated copper-arsenate treated wood, results in persistent residues inside the home and chronic exposure for the residents. In addition to contamination of the residence from product use, indirect contamination may occur from regional and global dispersion of these pollutants, with subsequent deposition and/or infiltration into the home.

People spend up to 90% of their time indoors, and for young children and those who work at home, this time indoors is spent primarily in the residence. Once pollutants enter the home, carpets, house dust, and home furnishings become long-term reservoirs. The common environmental weathering factors such as wind, rain, soil microbes and sunlight are not available for pollutant dispersion and degradation. Residues on floors and surfaces can become a source of exposure for young children through dermal absorption and the hand-to-mouth route of ingestion. These indoor reservoirs also are the source for indoor air levels of semivolatile compounds, which contribute to total exposure via the inhalation and dermal penetration route.

This work was designed to evaluate the extent to which persistent organic pollutants from diverse chemical classes are present in the outdoor soil, entryway soil, and house dust of several lower socioeconomic homes that have been studied previously for PAH. The persistent organic pollutants that were evaluated included organophosphate insecticides (OP), a cyanoaromatic fungicide (CN), organochlorine insecticides (OC), an acidic lawn herbicide (HA), a chlorinated phenol (multipurpose insecticide, fungicide, and herbicide; HA) and polychlorinated biphenyls (PCB). Analyses were conducted using several different analytical approaches. The methods were used to evaluate the precision and accuracy and trade-offs in these, that are made with different extraction, cleanup, and detection methods.

Results and Conclusions

The results of this study indicate that all persistent organic pollutants evaluated are present to some extent in the lower socioeconomic homes that we studied. The pollutants are primarily present in the house dust, rather than outdoor soils, and when present in both matrices are present at higher levels (weight basis in the media, g/g) in the house dust. Even those chemicals such as the lawn herbicide 2,4-D, that should not have been used in the home or near a foundation, were detected consistently in the house dust of all homes.

The levels of these persistent pollutants in house dust samples analyzed here are similar to the average levels that have been reported for these pollutants in other studies. In general, levels in dust ranged from low (0.02 g/g) to moderate levels (0.5 g/g), and in a few cases for the current, in-use insecticides diazinon and chlorpyrifos, levels above 1 g/g, up to 25 g/g, were found. The fungicide chlorothalonil was detected at lowest levels and least frequently. The insecticides diazinon and chlorpyrifos, lawn herbicide 2,4-D, and the insecticide/fungicide pentachlorophenol (PCP) were the analytes detected most frequently.

The comparison of analytical methods in this study indicated that sonication extraction with a simple solid phase extraction (SPE) cleanup step may provide more reliable data than that which can be achieved with Soxhlet extraction and no cleanup. To the analyst in the laboratory, the value of SPE cleanup is readily apparent. A significant amount of highly colored, polar material remains on the SPE cartridge after elution of the pesticide analytes of interest. This polar material, if concentrated and injected into a chromatographic system, can seriously compromise the integrity and performance of the GC injector and column. The calibration data for some pesticides, such as diazinon, are not seriously affected by the buildup of non-chromatographable material in the injector or on the first meter of the column, while other pesticides such as DDT and chlorothalonil are seriously affected by this material within a few analyses. Therefore, cleanup of a complex house dust extract becomes a necessary component of trace analytical work.

The similarities in recovery for GC/ECD and GC/MS analyses of each pesticide with the sonication/SPE approach, suggest that an additional benefit to this approach is the possibility of conducting analyses with lower cost GC/ECD analyses, rather than with higher cost GC/MS analyses. For soil, the relative percent difference (RPD) in recovery between the two detection techniques was generally quite good, <30%. For dust extract, the RPD for analyte recoveries between detection techniques for extracts that have not undergone cleanup was often unacceptably high, >50%. This variability may be due to both interferences and degradation in measurement performance. In contrast, the recoveries for dust extracts where cleanup was used, and then analyzed with the two techniques, showed very good agreement, RPD < 40%. The data generated here tended to indicate that with cleanup of either soil or dust extracts, similar quantification results may be expected using either GC/ECD or GC/MS detection.

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***Nancy K. Wilson** is the EPA Project Officer (see below).*
The complete report, entitled "Method Validation and Application for Semivolatile Organic Compounds in Dust and Soil: Pesticides and PCBs," (Order No. PB98-113376; Cost: $21.50, subject to change) will be available only from

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